

CLAIMS

What is claimed is:

1. A substrate assembly, comprising:

a support surface; and

5 a plurality of high-K dielectric layers over said support surface, wherein a common metal is present in at least two adjacent layers of said plurality.

2. The substrate assembly in claim 1, wherein said plurality of high-K dielectric layers comprises a first high-K dielectric layer contacting said support surface.

10 3. The substrate assembly in claim 1, further comprising a barrier layer between said support surface and said plurality of high-K dielectric layers.

4. The substrate assembly in claim 1, wherein said support surface is a capacitor
15 electrode.

5. The substrate assembly in claim 1, wherein said plurality of high-K dielectric layers defines a thickness of at most 200 Angstroms.

20 6. The substrate assembly in claim 5, wherein said plurality of high-K dielectric layers comprises a first high-K dielectric layer contacting said support surface and defining a thickness of at least a monolayer.

7. The substrate assembly in claim 6, wherein said first high-K dielectric layer defines a thickness of at least 10 Angstroms.

8. A capacitor dielectric, comprising:

- 5 a first high-K capacitor dielectric comprising a metallic element; and
 a second high-K capacitor dielectric comprising said metallic element and
 contacting said first high-K capacitor dielectric.

9. The capacitor dielectric in claim 8, wherein said first high-K capacitor dielectric
10 defines a first thickness; and wherein said second high-K capacitor dielectric defines a
second thickness that is different from said first thickness.

10. The capacitor dielectric in claim 8, wherein said first high-K capacitor dielectric and
said second high-K capacitor dielectric are oxides.

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11. The capacitor dielectric in claim 10, wherein said first high-K capacitor dielectric is a
first oxide; and wherein said second high-K capacitor dielectric is a second oxide different
from said first oxide.

20 12. The capacitor dielectric in claim 10, wherein said first high-K capacitor dielectric
contains a first amount of oxygen; and wherein said second high-K capacitor dielectric
contains a second amount of oxygen different from said first amount.

13. A capacitor structure, comprising:

a first electrode layer;

a dielectric layer disposed over said first electrode layer, wherein said dielectric

layer comprises a plurality of consecutively-positioned sub-layers, wherein

5 each of said sub-layers comprises a high-dielectric-constant material, and

wherein said dielectric layer comprises oxygen and an additional element

common to all sub-layers of said plurality; and

a second electrode layer disposed over said dielectric layer.

10 14. A method of insulating a semiconductor device, comprising:

providing a series of insulating layers for said semiconductor device under

oxidizing conditions; and

controlling oxidation beyond said series of insulating layers by way of said

oxidizing conditions.

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15. The method in claim 14, wherein said step of providing a series of insulating layers

comprises providing a series of insulating layers defining a total thickness; and wherein

said step of controlling oxidation comprises ensuring that a cumulative effect on oxidation

from providing said series of insulating layers is less than an effect of oxidizing one

20 insulating layer defining said total thickness.

16. The method in claim 15, wherein said step of providing a series of insulating layers

comprises providing a series of oxide layers.

17. The method in claim 16, wherein said step of providing a series of oxide layers comprises providing a series of high-K oxide layers.

- 5 18. A method of depositing a high-K dielectric onto a surface, comprising:
- providing a first layer of said high-K dielectric over said surface using a first group of oxidation parameters that generally insufficient to oxidize said surface; and
- providing a second layer of said high-K dielectric over said first layer using a
- 10 second group of oxidation parameters that generally insufficient to oxidize said surface.

19. The method in claim 18, further comprising a step of depositing a barrier layer onto said surface; and wherein said step of providing a first layer of said high-K dielectric

15 comprises depositing said first layer onto said barrier layer, wherein said first group of oxidation parameters allow oxidation of said barrier layer and are generally insufficient to oxidize said surface.

20. The method in claim 18, wherein said step of providing a first layer comprises:

20 depositing a material; and

subsequently oxidizing said material using said first group of oxidation parameters.

21. The method in claim 18, wherein said step of providing a first layer comprises depositing a material using said first group of oxidation parameters.

22. The method in claim 18, further comprising a step of reoxidizing a selection of said
5 first layer and said second layer using a third group of oxidation parameters that are generally insufficient to oxidize said surface.

23. A method of providing insulation, comprising:

10 providing a substrate configured to receive a high-K dielectric material having a thickness and resulting from a first set of oxidizing parameters and only one deposition step; and
depositing said thickness of said high-K dielectric material onto said substrate in a plurality of deposition steps using at least a second set of oxidizing parameters that allow less oxidation than said first set.

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24. The method in claim 23, wherein said step of depositing said thickness of said high-K dielectric material comprises additionally using said first set of oxidizing parameters.

25. The method in claim 23, wherein said step of depositing said thickness of said high-K
20 dielectric material comprises additionally using a third set of oxidizing parameters that allow more oxidation than said first set.

26. A method of processing a capacitor electrode configured to oxidize in response to providing an amount of high-K oxide for said electrode using a first set of oxidizing conditions including a process time, an ambient temperature, an ambient pressure, an ambient atmosphere, and excitation source values; wherein said method comprises:

- 5 providing a first portion of said amount of high-K oxide for said electrode using a second set of oxidizing conditions that are less aggressive than said first set; and
- providing a second portion of said amount of high-K oxide.

10 27. The method in claim 26, wherein said step of providing a second portion comprises providing said second portion at a temperature differing from a temperature included as part of said second set of oxidizing conditions.

 28. The method in claim 26, wherein said step of providing a second portion comprises

15 providing a second portion in an ambient atmosphere differing from an ambient atmosphere included as part of said second set of oxidizing conditions.

 29. The method in claim 26, wherein said step of providing a second portion comprises providing a second portion differing in depth from said first portion.

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30. A method of forming a capacitor structure for a substrate assembly, comprising:
forming a first electrode layer on said substrate assembly;
forming a first capacitor dielectric layer portion over said first electrode layer, said
first capacitor dielectric layer portion comprising a metal element;
5 forming a second capacitor dielectric layer portion over said first capacitor
dielectric layer portion, said second capacitor dielectric layer portion
comprising said metal element, wherein said first capacitor dielectric layer
portion and said second capacitor dielectric layer portion in combination
provide at least a portion of a total capacitor dielectric layer, and wherein
10 said total capacitor dielectric layer exhibits a dielectric constant greater
than ten; and
forming a second electrode layer over said total capacitor dielectric layer.

31. The method of claim 30, wherein said total capacitor dielectric layer exhibits a
15 dielectric constant greater than twenty.

32. The method of claim 30, wherein said total capacitor dielectric layer comprises a
dielectric material selected from a group consisting of: perovskites, ferroelectrics, high-
dielectric-constant oxides, doped versions of each of said preceding materials, and
20 combinations thereof.

33. The method of claim 32, wherein said step of forming a first electrode layer comprises forming said first electrode layer using a first conductive material selected from a group consisting of: doped silicon, platinum, palladium, rhodium, gold, iridium, silver, titanium nitride, tin nitride, ruthenium nitride, zirconium nitride, ruthenium dioxide, tin oxide, titanium monoxide, and combinations thereof.

34. The method of claim 33, wherein said step of forming a second electrode layer comprises forming said second electrode layer using a second conductive material selected from a group consisting of: copper, platinum, palladium, rhodium, gold, iridium, silver, titanium nitride, tin nitride, ruthenium nitride, zirconium nitride, ruthenium dioxide, tin oxide, titanium monoxide, titanium silicide, aluminum, and combinations thereof.

35. The method of claim 30, wherein said total capacitor dielectric layer comprises a dielectric material selected from a group consisting of: (Ba,Sr,Pb,La)(Ti,Zr)O₃, bismuth titanate, potassium tantalate, lead niobate, lead zinc niobate, potassium niobate, lead magnesium niobate, tantalum pentoxide, and combinations thereof.

36. The method of claim 35, wherein at least a portion of said total capacitor dielectric layer is doped with a dopant material selected from a group consisting of: Na, Al, Mn, Ca, La, Nb, F, K, Cr, Mn, Co, Ni, Cu, Zn, Li, Mg, Cl, V, Mo, Ce, Pr, Nd, Sn, Eu, Gd, Tb, Dy, Ho, Er, Ta, W, and combinations thereof.

37. A method of allowing capacitance to be generated, comprising:

providing a plurality of high-K dielectric layers for a capacitor, said plurality
representing a continuous sequence of materials sharing a common non-
oxygen component; and

5 providing an oxidizing environment for said plurality of high-K dielectric layers.

38. The method in claim 37, wherein said step of providing a plurality of high-K
dielectric layers comprises depositing a plurality of oxide layers; and wherein said step of
providing an oxidizing environment comprises providing said oxidizing environment
10 during said step of depositing a plurality of oxide layers.

39. The method in claim 37, wherein said step of providing a plurality of high-K
dielectric layers comprises depositing a plurality of non-oxide layers; and wherein said
step of providing an oxidizing environment comprises providing an oxidizing environment
15 after depositing each non-oxide layer of said plurality of non-oxide layers.

40. The method in claim 37, wherein said step of providing a plurality of high-K
dielectric layers comprises depositing a plurality of oxide layers; and wherein said step of
providing an oxidizing environment comprises providing an oxidizing environment after
20 depositing all of said plurality of oxide layers.

41. The method in claim 37, wherein said step of providing an oxidizing environment
comprises providing a rapid thermal oxidation environment.

42. The method in claim 37, wherein said step of providing an oxidizing environment comprises providing a furnace oxidation environment.

5 43. The method in claim 37, wherein said step of providing an oxidizing environment comprises providing a plasma oxidation environment.

44. The method in claim 37, wherein said step of providing an oxidizing environment comprises providing an anodic oxidation environment.

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45. A method of providing a capacitor dielectric defining a total thickness, comprising:
depositing an initial layer of a high-K capacitor dielectric, said initial layer
defining an initial thickness that is less than said total thickness; and
depositing an additional amount of said high-K capacitor dielectric onto said initial
15 layer, said additional amount defining an additional thickness, wherein said
initial thickness plus said additional thickness equal said total thickness.

46. The method in claim 45, wherein said step of depositing an initial layer comprises
depositing an initial layer defining an initial thickness ranging from 10% to 40% of said
20 total thickness.

47. The method in claim 45, wherein said step of depositing an initial layer comprises depositing an initial layer defining an initial thickness ranging from about 14% to 80% of said total thickness.

5 48. A method of depositing multiple layers of a high-K capacitor dielectric on a workpiece in a furnace, comprising:

establishing deposition parameters within said furnace, comprising:

introducing a tantalum precursor into said furnace at a rate ranging from

10 sccm to 2000 sccm,

10 introducing an oxygen-containing gas into said furnace at a rate ranging

from 0.1 SLM to 5 SLM,

establishing a pressure inside said furnace ranging from 0.1 Torr to 10

Torr, and

establishing a temperature inside said furnace ranging from 400 °C to less

15 than 800 °C;

exposing said workpiece to said deposition parameters for less than 30 minutes;

allowing a first tantalum-based layer to form on said workpiece in response to said

exposing step; and

depositing a second tantalum-based layer directly onto said first tantalum-based

20 layer.

49. The method in claim 48, wherein said step of establishing a temperature inside said furnace comprises establishing a temperature inside said furnace of around 450°C.

50. The method in claim 48, wherein said step of exposing said workpiece to said deposition parameters comprises exposing said workpiece to said deposition parameters for about one minute.

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51. The method in claim 48, wherein:

said step of introducing a tantalum precursor comprises introducing tantalum chloride; and

said step of introducing an oxygen-containing gas comprises introducing N₂O.

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52. A capacitor dielectric, comprising a plurality of capacitor dielectric layers defining a total thickness ranging from 50 to 70 angstroms, wherein each layer of said plurality is a high-K dielectric defining an individual thickness ranging from 10 to 40 angstroms in thickness, and wherein each layer of said plurality comprises a metal oxide included within an adjacent layer of said plurality.

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53. The capacitor dielectric of claim 52, wherein at least a lowest layer of said plurality defines an individual thickness of about 20 angstroms.

20 54. A method of providing a BST dielectric, comprising:

forming an initial BST layer at a temperature of less than 650°C for a time

sufficient to define a layer ranging from 20 to 80 Angstroms thick; and

forming a subsequent BST layer over said initial BST layer.

55. The method in claim 54, wherein said step of forming an initial BST layer comprises forming an initial BST layer at a temperature of at least 400°C.

5 56. The method in claim 55, wherein said step of forming a subsequent BST layer comprises forming a subsequent BST layer onto said initial BST layer.

57. A method of forming an amount of Ta₂O₅ over a metal electrode, comprising:
providing a first portion of Ta₂O₅ over said metal electrode at a temperature of less
10 than 500°C, wherein said first portion is less than said amount; and
providing an additional portion of Ta₂O₅ onto said first portion at a temperature
ranging from 400°C to 700°C.

58. The method in claim 57, wherein said step of providing a first portion of Ta₂O₅
15 comprises providing a first portion having a first thickness; and wherein said step of
providing an additional portion of Ta₂O₅ comprises providing an additional portion having
a second thickness different from said first thickness.

59. A metal-insulator-silicon device, comprising:

a top metal electrode;

a top Ta₂O₅ layer under said top metal electrode;

a bottom Ta₂O₅ layer under said top Ta₂O₅ layer and contacting said top Ta₂O₅

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a silicon nitride layer under said bottom Ta₂O₅ layer; and

a bottom silicon electrode under said silicon nitride layer.